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Bender Gestalt Linkage Consistency in Adults

by

© Corinne Suzanne Bobb

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SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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Date..OCTOBER 8, 1985.....

Dedication

To my parents,
Robert and Vera Bobb,
for their encouragement,
support and assistance towards
the completion of this thesis.

Abstract

An objective scoring system for the Bender Gestalt Test (BGT) measuring deviations in the consistency of the reproductions of examinees was employed in this study. The purpose was to measure the reliability and validity of the scoring system, and to evaluate its sensitivity with regard to distinguishing among normal, psychotic and brain-damaged individuals. Eighty BGT protocols were scored for deviations in consistency, and analyses of variance were used to determine if there were significant differences among the three groups. It was hypothesized that inconsistency in the reproduction of the BGT design properties: 1)would be greater in the clinical group protocols than in those of the non-clinical group; 2)would be independent of age and sex differences; and, 3)would discriminate between the clinical groups, with reproductions by the brain-damaged group showing greater inconsistency than those by the psychotic group. Results supported the hypotheses with an interesting supplemental finding that specific age and sex differences did appear. Theoretical implications of the results were discussed. Limitations of the scoring system and research design were presented, as well as, recommendations for future research.

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The opportunity to work with the writer's supervisor, Dr. D. Spearman, throughout this project will be forever valued. His gracious support and editorial guidance were most appreciated.

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I. INTRODUCTION

In his early perceptual studies, Wertheimer(1923) created a series of Gestalt figures which he utilized as a means of investigating the nature of visual Gestalten and the principles which determine them. The principles of Gestalt psychology as they related to perception were thought to be experimentally demonstrated when normal individuals were asked to verbally describe the designs. His subjects tended to perceive images in a gestalt, and organized the stimuli based on the proximity and similarity of the parts and the continuity and inclusiveness of the structure. These data led to the formulation of classical Gestalt theory which states that people are less likely to see the parts that make up an image, but rather perceive the whole or total quality of the stimulus based on certain fundamental principles of perception which were described by Wertheimer's subjects.

Bender(1938) selected from Wertheimer's original designs nine figures which she adapted to be more suitable for use in her clinical work. The intent behind Bender's research was to construct a visual-motor performance test to investigate Gestalt functions of perception which could be administered in a non-verbal manner to her patients. The Bender Gestalt Test (BGT) consists of these nine designs

which are serially presented to the examinee for copying.'

Bender's rationale for the use of the test as a clinical instrument is based on the fundamentals of Gestalt psychology developed primarily by Wertheimer, Koehler and Koffka. These Berlin psychologists taught that a structuralized configuration is immediately perceived in such a way that it corresponds with the external stimulating world. The pattern is the result of an interaction between the sensory field and the stimulus(Kohler, 1941).

Bender, however, contended that traditional Gestalt psychology had been hesitant to consider the emotional components inherent in perceptual processes(Woltmann, 1952). Influenced by the research of Schilder(1942), Bender added dynamic concepts to the basic Gestalt tenets of total reaction to the total situation(Halpern, 1951). She described the perception of visual stimuli as a continuing dynamic process or function. "The whole setting of the stimulus and the whole integrative state of the organism determine the pattern of response(Bender, 1949, p. 165)." In other words, the individual in the act of perceiving always adds something to the experienced perception(Schilder, 1938).

' The BGT cards and administration manual were copyrighted in 1946 by Dr. L. Bender and the American Orthopsychiatric Association. Other adaptations of the original designs have since become available(Hutt, 1977). For the purposes of this study, unless otherwise stated, discussion pertains only to the copyrighted set of cards.

Bender(1949) elaborated further by suggesting that there is a tendency not only to perceive the gestalt but to complete the gestalt and to reorganize it in accordance with principles biologically determined by the sensory-motor pattern of action. This guiding pattern of action may be expected to vary in maturation or growth levels and in organic or functional pathological states. Halpern(1951) added additional comments to Bender's extension of the theory by stating that the test product is, then, an indication of how the stimulus is perceived, organized, what it means to the examinee, what is done to simplify it, and what is added to it. Likewise, the capacity to reproduce the percept, the level of visual motor coordination, and action patterns are revealed.

Bender relied on an impressionistic interpretation of test protocols of adult patients, and, consequently did not provide an objective scoring system for the BGT. While numerous authors have subsequently presented objective scoring sytems for the BGT(Billingslea, 1948; Kitay, 1950; Peek & Quast, 1951; Pascall & Suttell, 1951; Koppitz, 1958, 1963; Hain, 1964; Pauker, 1966; and Hutt, 1977), most fail to take into account the underlying Gestalt theory, and consequently there is a lack of appropriate rationale for the test (Bender, 1963). Over the years, most of the scoring systems have been neglected. In a review of the literature, Tolor & Brannigan (1980) report that "the most widely accepted and presently flourishing scoring systems are those

of Pascal and Suttell (1951) and Koppitz (1958, 1963)(p. 166)." The former is purported to measure ego strength, the latter is designed specifically for children. In a more recent study (Field, Bolton & Dana, 1982) three of the more respected BGT scoring systems, Hutt(1977), Pascal & Suttell(1951), and Pauker(1966) were evaluated. The authors conclude that while all three are reliable scoring systems, unfortunately they fail to provide evidence which would support that they are valid indicators of psychopathology in adults. Hain(1964) compared small groups of brain-damaged, psychiatric, and non-brain-damaged patients to obtain a scoring method for discriminating between the brain-damaged group and the others. He successfully identified approximately 80% of all subjects correctly, but unfortunately misidentified 41% of the brain damaged patients.

Despite the difficulties and controversies which exist over the scoring of the BGT, it "retains sufficient vitality to be one of the most commonly employed assessment techniques in the entire spectrum of clinical diagnostic tools" (Tolor & Brannigan, 1980, p. xv). The BGT has been ranked as the fifth most frequently recommended psychological instrument in clinical assessment (Wade, Baker, Morton & Baker, 1978). Its popularity is partly due to its usage both as a visual motor test for organicity(Marley, 1982; Lezak, 1983), and as a projective technique for studying personality (Hutt, 1951; Hammer,

1954; Lerner, 1972; DeCato & Wicks, 1976) and psychopathology(Clawson, 1959; Byrd, 1956). Numerous authors(Tolor, 1957; Billingslea, 1963; Goldfried & Ingling, 1964; and Holmes, Dungan & Medlin, 1984) suggest, however, that precautionary measures should be taken when using the BGT as a projective tool because of the subjective nature of the symbolic interpretations of the test designs. The BGT also maintains its popularity because of the obvious advantages of the test, which include, brevity, simplicity, an easy administration, economy in time and materials, its apparent mildness as far as the subject is concerned(Suczek & Klopfer, 1952), and its potential richness of non-verbal data for clinical interpretation(Dana, Field & Bolton, 1983).

Since the BGT may be described as an integral part of most test batteries (Tolor & Brannigan, 1980; Keogh, 1969), many psychologists feel there still exists a great need for a scoring system that is both reliable and valid (Koppitz, 1963; Lacks & Newport, 1980). The importance of increasing the sensitivity of the BGT to discriminate between organics and schizophrenics lies in the frequency of use of this instrument, and its potential as a quick screening device that could be administered by paraprofessionals if necessary (Mermelstein, 1983).

The purpose of the present study is to present an objective scoring system for the BGT that can provide both a reliable and valid basis for reaching pertinent conclusions

about adult perceptual-motor functioning. While most objective scoring systems attempt to quantify the overall accuracy of the reproductions of each separate design, they also manage, at the same time, to disrupt the Gestalt by arbitrarily fragmenting the designs. Bender(1970) cautioned against such efforts. One way to avoid this fragmentation is to consider the consistency of the reproductions. "There are identical structural properties throughout the designs which make possible an investigation of the consistency of sequential reproduction of those properties of the test designs (Spearman, 1984)." Knight(1972) found significant results using this linkage consistency to discriminate between adjusted and maladjusted children.

Although there are no properties which are common to all designs, there are consistencies involving all of them, as follows (and as illustrated in Figure 1):

1. Designs A, 4, 7, and 8 each contain lines of identical length. These are (a) the length of the sides of the square in design A; (b) the sides of the square in design 4; (c) the lines forming the acute angles of the hexagon in design 7; and (d) the lines forming the acute angles of the hexagon in design 8(Linkage 1).

2. The circular features in designs A, 4 and 5 have identical diameters(Linkage 2).

3. Designs 3, 4 and 8 share (a) the length of the central row of dots (axis) in design 3; (b) the distance between the tails of the curved figure in design 4; and, (c)

the length of the horizontal sides of the hexagon in design 8(Linkage 3).

4. Designs 5, 7 and 8 share (a) the length of the extension in design 5; (b) the length of the longer sides of the hexagon in design 7; and, (c) the length of the halfsides (longer sides) of the hexagon in design 8(Linkage 4).

5. The length of the row of dots in design 1 and the length of the horizontal rows of ovals in design 2 are identical(Linkage 5).

6. Designs 4 and 6 share (a) the distance between the centres of the arms of the curved figure in design 4; and, (b) the distance between the apexes of the first and third curvatures and the second and fourth curvatures of the vertical wavy line in design 6(Linkage 6).

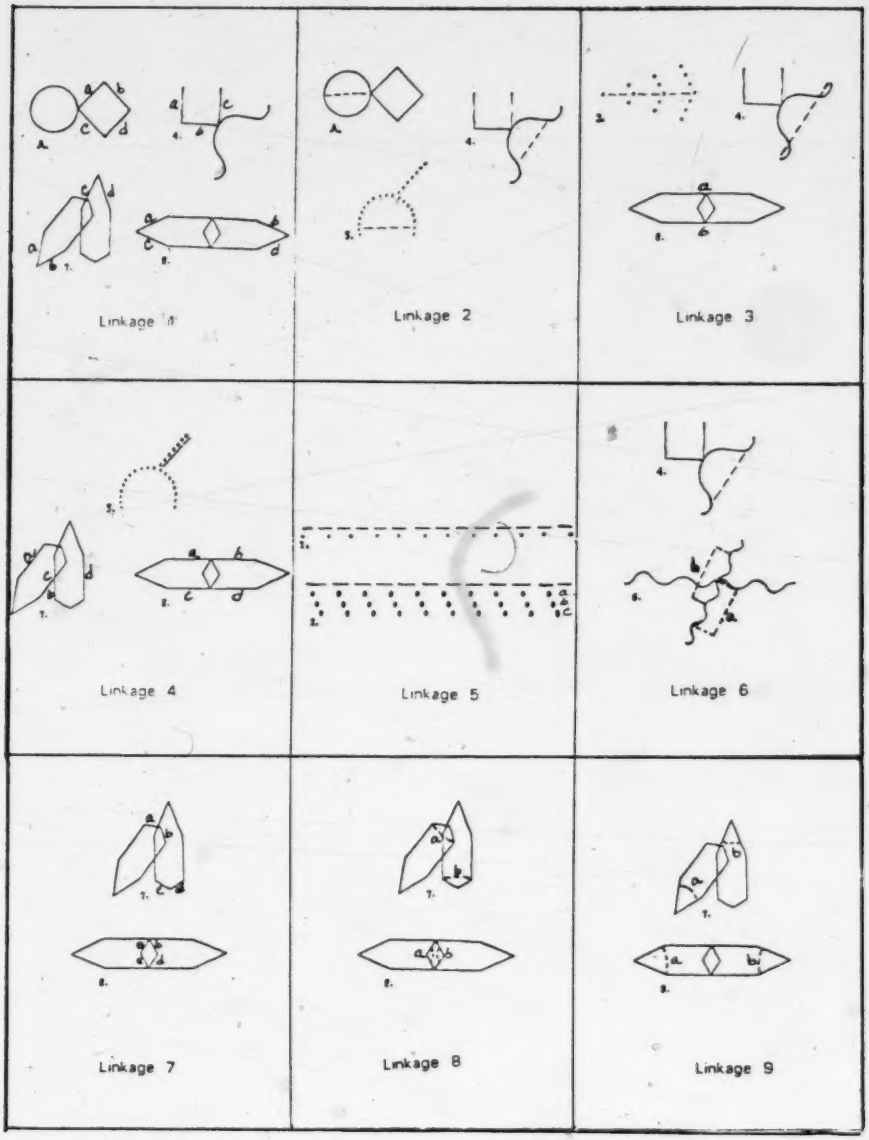
7. The length of the sides forming the obtuse angles of the hexagon in design 7 and the length of the sides of the diamond in design 8 are identical(Linkage 7).

8. The size of the obtuse angles of the hexagons in design 7 and the obtuse angles of the diamond in design 8 are equal(Linkage 8).

9. The size of the acute angles in the hexagons in design 7 and the acute angles in the hexagon in design 8 are identical(Linkage 9).

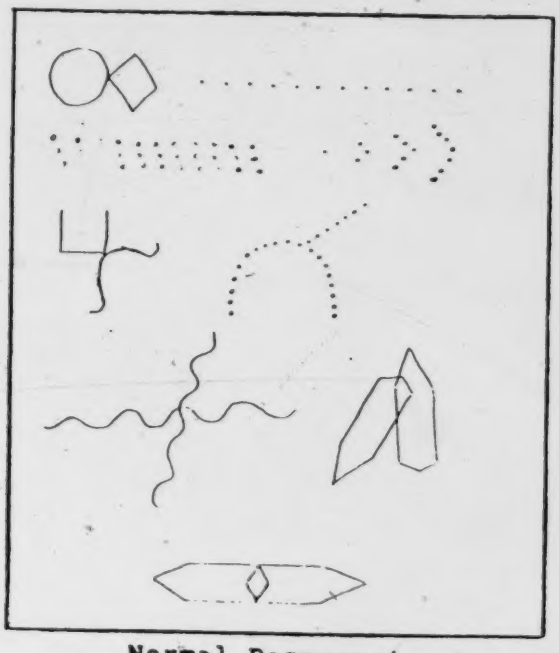
These nine sets of common properties are referred to as linkages (Spearman, 1984).

Figure 1. Linkages'

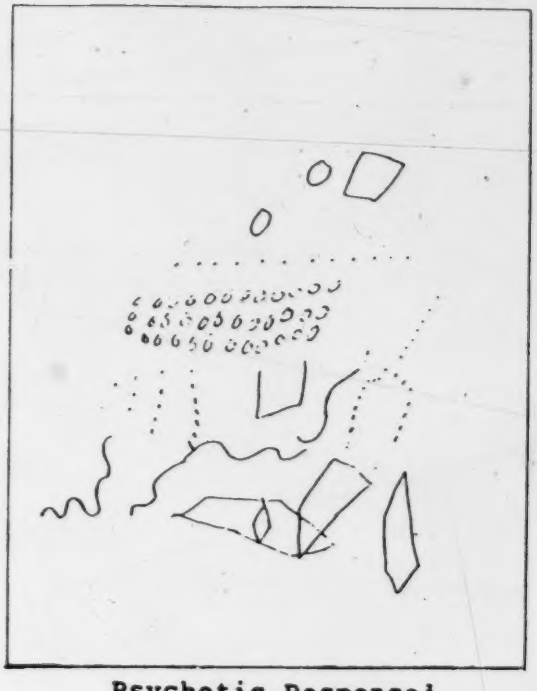


'The actual size of the original BGT designs used in Figure 1 has been substantially reduced.

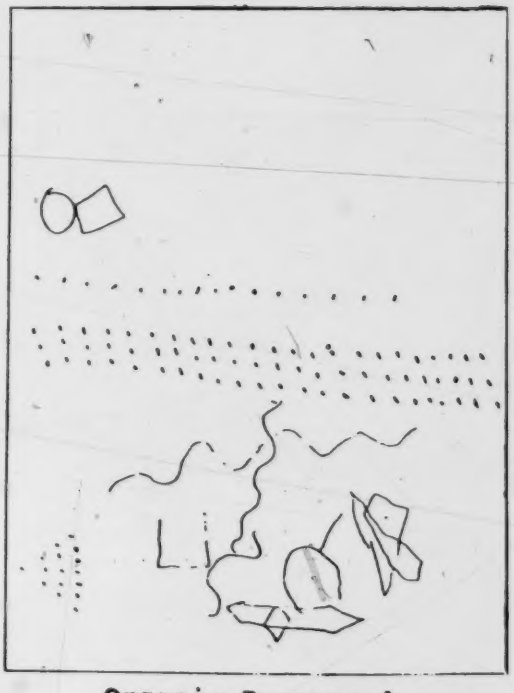
Figure 2. Examples of Bender Gestalt Protocols



Normal Response[1]



Psychotic Response[2]



Organic Response[2]

---

[1]reduction of a protocol presented in Lerner(1972) p. 53.

[2]reduction of protocols presented in Hutt(1977)pp. 198, 220.

The consistency of the examinee's reproductions of the design properties were analyzed from two points of view: first, consistencies or irregularities in each reproduction from the properties as they appear on the stimulus card; second, consistencies or irregularities in each linkage (or property shared between two or more designs) in the reproductions. More specifically, the initial reproduction of any property served as the standard against which subsequent reproductions of that property were compared for consistencies or deviations.

There are three studies reported in the literature that are tangentially related to consistency and visual motor performance. McPherson and Pepin(1955) found that examinees are consistent in their reproductions of Bender Gestalt designs when two different methods of motor manipulation are employed, by drawing them on paper, and by placing pieces of felt in the appropriate position to construct the designs. Their data seemed to indicate that the reproduction of the Bender Gestalt figures is influenced more by covert perceptual responses than by motor techniques. Their measure of consistency, however, does not relate to the measure of consistency as it is defined in this study. A drawing task procedure administered by Wolff(1942) in which his subjects were asked to draw a set of geometrical forms under four different conditions, and then asked to break down their own patterns, showed that over fifty percent of the forms were consistent with the others produced in different conditions.

This suggests that forms drawn under such conditions were reliably related to the personalities of the subjects and might offer diagnostic possibilities(Bell, 1948). Shapiro, Field and Post(1957) used a subjective scoring method to differentiate elderly organic and non-organic psychiatric patients. They attempted to measure the angles and length of the diagonals in the patients' reproductions. They did not succeed in objectifying the original subjective scoring criteria, as was done here, and as a result, failed to formulate precise and testable generalizations about the effects of brain damage in elderly patients.

The rationale for using drawing tests for assessing visual motor and personality functioning can be summarized in the following way. Although visual perception and drawing skill are both necessary in a copying test, the simple combination of these two abilities does not totally explain the copying process. Difficulties in reproduction involve sensory motor integrative processes. Studies have consistently demonstrated that examinees regardless of age, organicity, mental retardation, or degree of emotional disturbance are able to perceive designs accurately, as indicated by their ability to pick the correct match from a display, yet may be unable to reproduce them correctly(Haworth, 1970).

Theoretical support for using the BGT as a screening device to detect brain disordered individuals has received cursory treatment in the literature(Tolor & Schulberg,

1963). Performance on a copying test may, however, be thought of as a three-stage dynamic process involving, the perception of the stimulus; the associations given to the perception; and, the arousal of the limbic system. When an individual perceives the stimulus on the Bender Gestalt card, it suggests certain impressions, even though the individual may be unaware of a visual object(Guildford, 1967). Related associations are stirred by the perception, and at the same time, the emotions linked with the associations are believed to be aroused. Some card stimuli may touch complexes in the memory associative system which cause even greater disturbances in the emotional centers. If the emotional arousal is considerable the system will be unable to return to a stable resting-level position immediately. When an individual fails to stabilize to the emotional over-arousal, the magnitiude of disruption of the cognitive and motor copying operations and inconsistency of copying behavior is increased. Variations in the Bender Gestalt series are thought to provide ample stimulation to generate fluctuations in the examinee's level of hypothalamic arousal and general psychomotor function.

It follows from this hypothesis that only an unemotionally involved "complex-free" performance would result in a perfect copy of the figures. An emotionally stable individual should be able to retain composure throughout the test, and will not be distracted by emotions. Consequently, good copies are more likely to be produced.

Emotionally unstable individuals are particularly susceptible to over-arousal and can not habituate quickly. In a sense they lose control of their associative limbic and motor systems. If the ups and downs produced by the test become too great for them to establish homeostasis, then an abnormal or irregular copy may be produced. Brain damaged individuals can have a partial or total disruption in the dynamic processes called upon to complete the BGT. As a result, their performance on the test may be the most disrupted and inconsistent.

It follows from the above that measurement of the consistency of the reproductions of the examinee should be indicative of the degree of emotional stability and organicity.

Hypotheses:

1. Inconsistency in the reproduction of the BGT design properties will be greater in the clinical group protocols than in those of the non-clinical group.

2. Inconsistency in the reproduction of BGT design properties will discriminate between the clinical groups, with reproductions by the brain-damaged group showing greater inconsistency than those by the psychotic group.

3. Inconsistency in the reproduction of the BGT design properties is expected to be independent of age and sex differences.

II. METHOD

A. Subjects

The research sample consisted of 80 persons, 40 of whom were defined as clinical and 40 as non-clinical. The clinical sample consisted of 20 brain-damaged and 20 non brain-damaged patients admitted to psychiatric hospitals in Northern Alberta. The non-clinical sample consisted of 20 adults residing in a retirement community who were voluntary participants, and 20 university students who were participating in this study on a voluntary basis as partial fulfillment of a course requirement. They were matched with the clinical sample for sex and race. Complete demographics for the entire sample are presented in Table 1.

Exclusion criteria: no individual was included in the study who had been afflicted with any type of motor or muscular disorder (e.g. arthritis, Parkinson's disease, muscular dystophy), or who was involved in a medication regime or who suffered from visual impairment that might interfere with the ability to see and draw the Bender Gestalt figures.

B. Materials

#2 sharpened pencil with attached eraser

sheets of 8 1/2" x 11" white unlined bond paper

a table and two chairs for the examiner and examinee

a millimeter scale

a protractor

a metric circle template

a divider.

Bender Gestalt cards (1946 edition)

Minnesota Multiphasic Personality Inventory (MMPI)

C. Procedure

Forty non-clinical subjects were given the BGT individually by the same examiner according to a standard procedure for administration. The instructions were as follows:

> I am going to show you these cards (pointing to the stack of Bender Gestalt cards) one at a time. Each card has a design on it. I would like you to copy the design on this sheet of paper as accurately as you can. Here is the first one.

Following the completion of the BGT, the examinees were asked to compare their reproductions to the original designs. Their comments regarding inconsistencies in their own reproductions were noted by the examiner. In addition, a self administered MMPI was given to all examinees to complete. The MMPI served as a screening device for psychopathology in the non-clinical group, as well as, an objective measure of emotional stability.

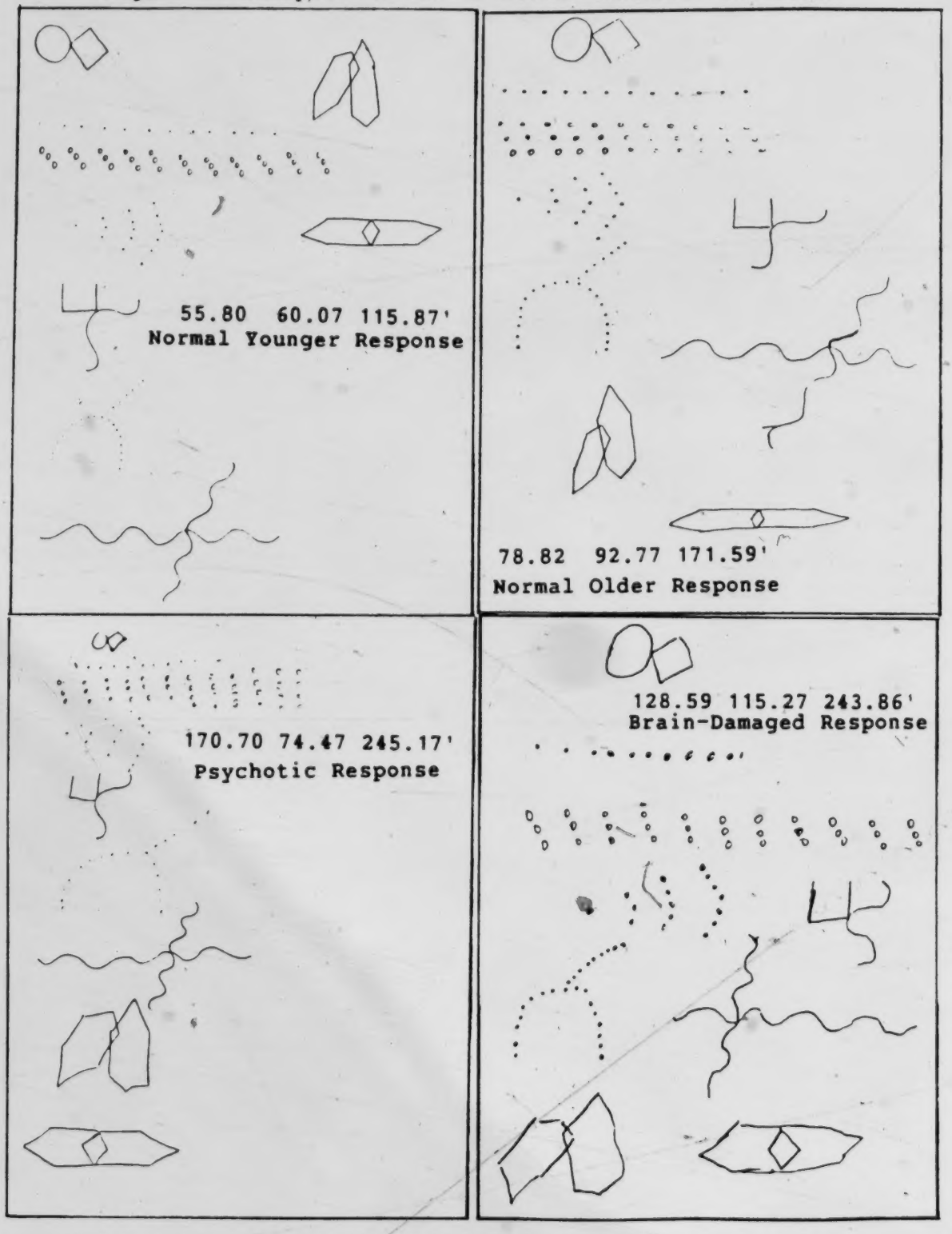
The Bender Gestalt protocols and the MMPI responses for the 40 clinical subjects were obtained from existing files at Northern Alberta Hosptitals where the tests are commonly employed as part of an assessment battery given to adults

admitted for psychiatric treatment.

D. Scoring

Measurements were obtained on the nine property linkages illustrated earlier (page 8), using dividers, a millimeter scale, a protractor, and a metric circle template. In most instances, the dividers were used to ascertain the property size, which was then measured on the millimeter scale. Exceptions to this procedure occurred for linkages 2, 8 and 9. For linkage 2, the metric circle template was used to determine the diameter of the circular figures. The protractor was used to measure the angles for linkage 8 and 9. Record forms were kept on which measures and calculations were recorded. Deviations from the objective stimulus size were calculated. The size of the initial stimulus property reproduction for each linkage was determined and deviations of subsequent property sizes from this standard were calculated and recorded in absolute numbers. Mean deviations from each of the above standards were calculated for each of the nine property linkages resulting in 18 mean deviation scores for each subject. These served as the measures included in the various analyses. Examples of the scoring sheets used are contained in Appendix A. Examples of scored Bender Gestalt protocols are presented in Figure 3.

Figure 3. Examples of Scored Bender Gestalt Protocols



'Linkage scores for objective consistency(linkages 1-9), internal consistency(linkages 1a-9a) and overall consistency(linkages 1-9a) respectively.

On a few of the clinical protocols certain reproductions were missing from the record. One of the advantages of the scoring system is that it is still employable in such instances because the scores are calculated using mean values. Occasionally when scoring an incomplete record there will be missing values for some linkages. In such instances of missing values in this study, the figures in the data are identified with the symbol (').

Interscorer reliability of the scoring system was estimated by randomly selecting 24 protocols and having them scored independently by two more individuals, in addition to the researcher, who had received approximately thirty minutes of instruction in the scoring technique. Pearson Product-Moment correlation co-efficients were computed on the three sets of scores. These are presented in Table 2. The interscorer reliability estimates range from .917 to .999 for the 18 linkage scores. The overall mean correlation coefficient is .982. These results suggest that the objective scoring system is highly reliable.

E. Analysis

To test the three hypotheses an analysis of variance was carried out for each of the 18 linkages using the appropriate grouping for each hypothesis. In addition, the data for each of the non-clinical and clinical groups were analyzed separately in a 2 x 2 analysis of variance in order to examine for age and sex effects within the two samples.

Where comparison of more than two means was involved and if no significant overall main effect was obtained, a Duncan's Test was used to examine the specific nature of the differences, if any, between means.

While performance on the BGT is apparently independent of drawing ability, it has been shown to be significantly related to amount of education(Anastasi, 1982). While attempts were made to match all four groups for educational level, it was not possible to do so in all instances. To correct for this, separate covariate analyses were run contolling for age and educational differences using the appropriate grouping for each hypothesis.

Analyses of variance were run to determine if there were significant differences between the groups regarding objective consistency (total score for linkages 1-9), internal consistency (total score for linkages 1a-9a), and overall consistency (total score for all linkages 1-9a). Where comparison of more than two means was involved and a significant main effect was obtained, a Neuman-Keuls Test was used to examine the specific nature of the differences between means.

III. RESULTS

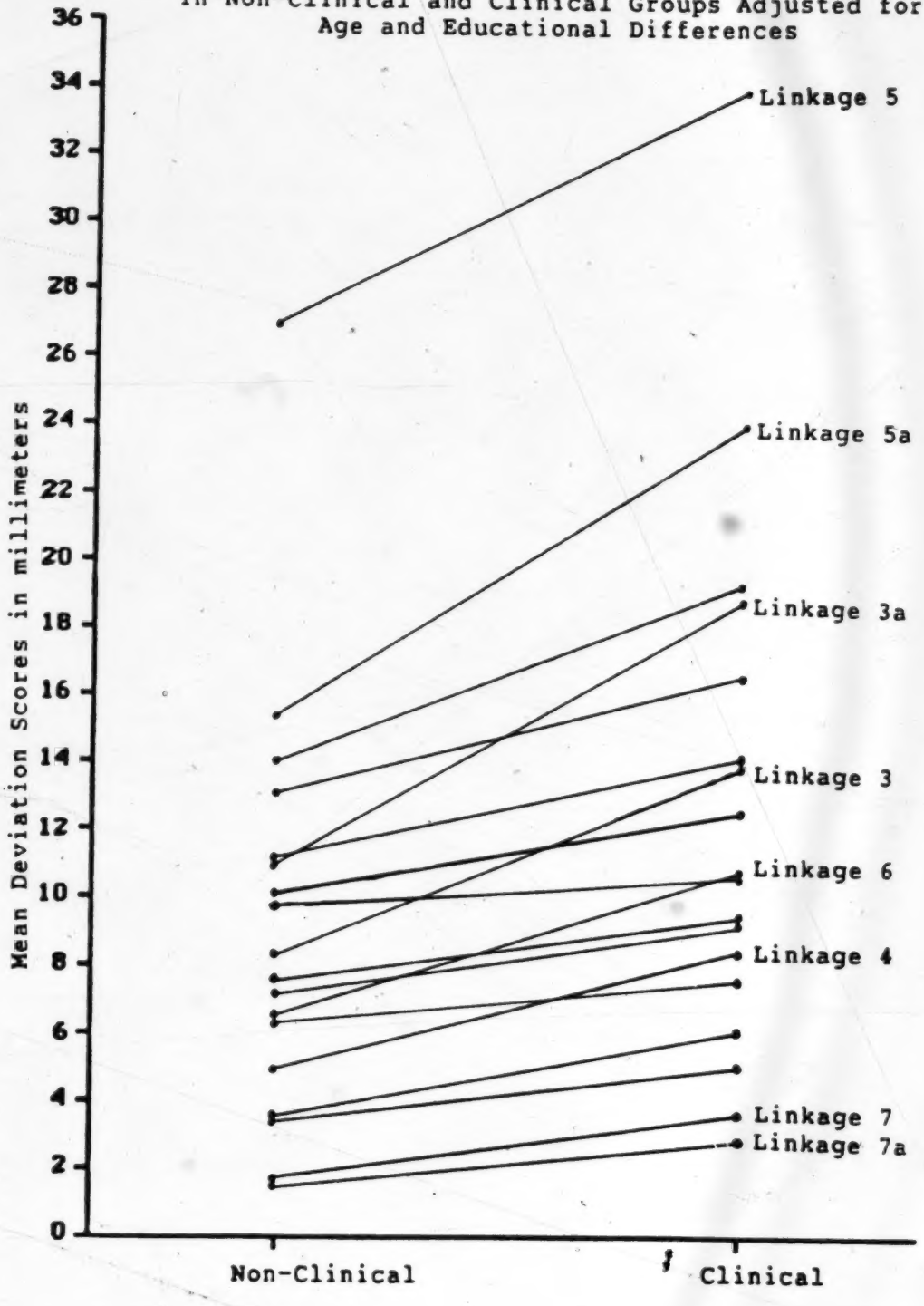
Non-Clinical and Clinical Hypothesis

The hypothesis that inconsistency in the reproduction of the BGT design properties would be greater in the clinical group protocols than in those of the non-clinical group was favorably supported. A two way (Group x Sex) analysis of variance (Table 3) indicated significant differences between the groups on 6 of the 18 linkages ($p<.05$). Complete results of the two way analysis of variance are shown in Appendix B. A two way (Group x Sex) covariate analysis controlling for age and educational differences indicated that overall the scores for each group were significantly different ($p<.05$). Mean deviation scores adjusted for age and educational differences were lower on the non-clinical protocols than on the clinical protocols for all 18 linkages. These scores are presented in Table 4, and illustrated in Figure 4.

Psychotic and Brain-Damaged Hypothesis

The hypothesis that inconsistency in the reproduction of the BGT design properties would discriminate between these clinical groups, with reproductions by the brain-damaged group showing greater inconsistency than those by the psychotic group was not strongly supported by the results. A two way (Group x Sex) analysis of variance

Figure 4.
Mean Deviation Scoring Trends for each of the Linkages in Non-Clinical and Clinical Groups Adjusted for Age and Educational Differences



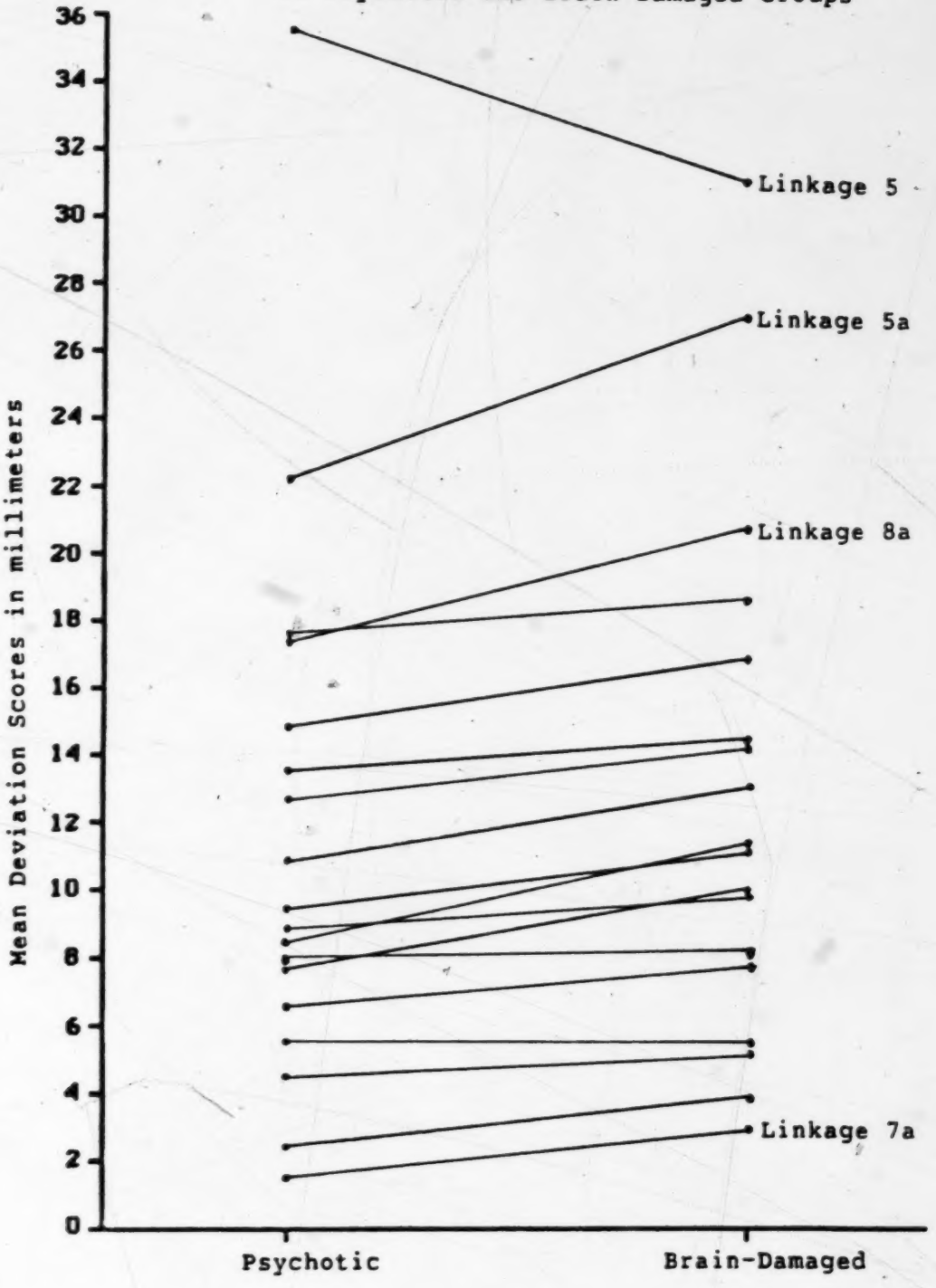
(Table 5) indicated significant differences between the two groups on only one of the 18 linkages, namely linkage 7a. Linkage 7a is a measure of internal consistency for short line reproduction (refer to Figure 1 for illustration of the linkages).

A graph (Figure 5) of the mean scores, however, illustrates that inconsistency was greater for the brain-damaged group than the psychotic group on 16 out of the 18 linkages. A Duncan's Test comparing the means of all four groups suggests that the mean deviation scores for the brain-damaged group are significantly different from at least one other group for 8 of the 18 linkages as presented in Table 6. Once again, on only one linkage, 7a, do the brain-damaged scores deviate significantly from the psychotic scores. Nevertheless, the Duncan's comparison distinguishes the brain-damaged group from the psychotic group scores which are significantly different from at least one of the other groups on 4 of the 18 linkages. The brain-damaged group scores were significantly different on 8 linkages, i.e., in twice as many instances.

Age and Sex Hypothesis

Based on the literature, it was expected that inconsistency in the reproductions of the BGT design properties would be independent of age and sex differences. To test this hypothesis a 2 x 2 (Group x Sex) analysis of variance was carried out between the older non-clinical

Figure 5.
Mean Deviation Scoring Trends for each of the Linkages in Psychotic and Brain-Damaged Groups



group (M age = 69.05) and the younger non-clincical group (M age = 23.80). These two groups were matched for education (M education of older group=12.65 years; M education for younger group=13.30 years; t-test (df=38); p<.320).

Results of the analysis showed significant age differences only for linkage 8a which is a measure of internal consistency for angle reproduction. The older group scored higher (more deviation) than the younger group on only slightly more than half of the linkages 10/18 (Table 7).

Significant sex differences were found for only one linkage (Table 8). It is of interest to note that this sexual difference appeared on linkage 8 which involves a measure of consistency in angle reproduction from the original stimulus. The males were far superior at this task than the females (mean deviation scores for males and females respectively were 11.537 and 15.900, p<0.011). Generally, the male scores were lower (less deviation) than the female scores on 14 out of the 18 linkages, although non-significant.

Although the clinical group was matched for age (M age of psychotic=30.45 years; M age of brain-damaged=30.1 years; t-test (df=38); p<.922) a 2 x 2 (Group x Sex) analysis of variance was done between the psychotic and brain-damaged groups to test for sexual differences. These results are presented in Table 9. While no significant differences were found, linkage 8 once again showed interesting differences

($p<.073$) with male scores lower than female scores. Although not significant, the trend was for the males to be more internally consistent (scores on linkages 1a-9a were lower than female scores on 7/9 linkages) and females more consistent with the original stimulus (scores on linkages 1-9 were lower than male scores on 8/9 linkages).

The results of a 4 x 2 (Group x Sex) analysis of variance for the entire sample (complete results of which are contained in Appendix C) reconfirmed the above findings. Significant sex differences were found only for linkage 8 (Table 10), (males M=12.787 and females M=16.872). Once again, the male scores tended to be lower, i.e., showing less deviation, than the females on 14 out of the 18 linkages, although not significantly so. A Duncan's post-hoc comparison (4 x 2) found no significant sex differences within the four groups (Table 11).

Complete results of the covariate analyses controlling for age and educational differences indicated, once again, that overall there were significant group differences, but that the sex differences were non-significant. The covariance results for the various analyses for each group are presented in Appendices E, F and G.

Combined Linkage Scores

The combined scores for linkages 1-9(a measure of objective consistency), linkages 1a-9a(a measure of internal consistency) and linkages 1-9a(the total deviation

score for all 18 linkages) were analysed by means of multiple t-test comparisons across all four groups. A Neuman-Keuls test was used to determine the specific nature of differences between means. The complete results are presented in Table 12. Of interest to note is that the younger non-clinical group showed significantly more internal consistency than the other three groups. The brain-damaged group was significantly different from both of the non-clinical groups on the overall score, while the psychotic group was significantly different from the younger group on the same measure.

Table 13 indicates that signficant differences were found on all three measures when comparisons were made between the two groups (non-clinical and clinical). In each instance the non-clinical group showed significantly more consistency.

Similar comparisons were also made between the sexes. Table 14 indicates that no significant sex differences were found between any of the three measures when the entire sample was analyzed. Nevertheless, when the sample was divided into two groups (non-clinical and clinical) some interesting sexual differences appeared. As Table 15 shows non-clinical males scored significantly better in objective consistency than the other three groups, clinical females scored significantly poorer than non-clinical males and females in internal consistency, while the non-clinical males scored significantly better than the clinical males

and females in overall consistency. A further breakdown of sexual differences across all four groups (4 x 2) was also done. Please refer to Table 16 for the indication of the significant sex differences between the eight groups.

In addition to the above comparisons, the same measures of objective and internal consistency were used to make within group comparisons. One purpose of which was to determine if these two measures are related. The results of these within group comparisons are presented in Table 17.

Only the older group shows a significant difference between objective and internal consistency. (This difference is discussed in more detail in the discussion section of this paper). This difference suggests that although these measures are related that there is a definite distinction to be drawn between them.

IV. DISCUSSION

As all of the results presented in the various tables indicate, the fact that significant differences were found between the two groups (non-clinical and clinical) and to a lesser extent between the three groups (normal, psychotic and brain-damaged) suggests that linkage consistency on the BGT could be used as an objective measure to differentiate among normal, psychotic and brain-damaged individuals.

At this point, however, the results are of more theoretical importance than they are of clinical usefulness. Cutoff scores could not be assigned until a substantial number of protocols have been scored. Even then, a word of caution should be interjected here, as has been previously emphasized by other authors(Filskov & Boll, 1981). Tymchuk & Nishihara(1976) cautioned that scores on the Bender cannot be used to classify subjects on an individual basis into brain-damaged and non-brain-damaged groups because of the great overlap in error scores. As a result of the statistical variability in the scores in all groups, other assessment measures are needed to make a complete a diagnosis.

Unexpected Findings

Age Differences

The results of Table 17 indicate that the older non-clinical group was the only group to show a significant difference between objective and internal consistency. It is

perhaps not surprising to see that they were on the average more objectively consistent i.e., responding to the external world. It is of interest to note that the younger non-clinical group and the psychotic group appeared more internally consistent, i.e., operating in their own little world, although not significantly so. One can only speculate as to why the modus operandi between these two age groups is in direct contrast. Perhaps the experience of the older group has taught them a preference in perceptual-motor response that the younger group has yet to learn. A more precise theoretical explanation may be that the older group is able to maintain a calmer regard towards the external stimuli which results in more objectively consistent reproductions. Garner(1962) has explored this topic in great detail.

> "Any given individual can be considered to face a decision concerning the extent to which he becomes structured internally (thus having his own integrated personality) and the extent to which he chooses to relate to the external world. The problem of balance between these two kinds of structure must be a real one (p. 344)."

Sex Differences

Knight(1972) found a significant sex difference for only one linkage, namely linkage 8. She attributed this difference to statistical chance stating that there was a high probability (0.50) that such a difference could occur by chance in a series of 18 statistical tests.

Interestingly, the present study also found only one significant sexual difference on the same linkage 8. This identical finding eliminates Knight's previous explanation of statistical chance.

The ability of males has been found to be superior to the ability of females in numerous spatial ability tasks (for an overview of the literature on sexual differences see Minton & Schneider, 1985, Chapter 10). Since linkage 8 involves accuracy of angle reproduction from the objective stimulus, the difference may be related to the now commonly held assumption that on the average males are superior to females in mathmatical, geometrical and visual spatial ability. Unfortunately, it is beyond the scope of this study to pursue this apparent sex difference further, even though continued investigation is warranted since significant sex differences on the BGT have generally not been found and/or reported in the literature.

Limitations of study

An unavoidable problem for this research design was the probable difference in attitudes which the two samples held during the administration of the BGT. The attitude of the clinical group taking the test as part of a psychological assessment in a clinical setting contrasts with the attitude of the non-clinical group who realized that their test protocols were for research purposes only, the results of which would not directly affect them in anyway. It is unwise

to speculate on how the effects of these different experiences might have influenced subject performance.

Secondly, the difficulty of selecting a psychotic group of patients who are free from organic impairment is always troublesome. As Heaton, Baade & Johnson(1978) have stated, "...groups of unselected institutionalized chronic schizophrenics will appear organic on neuropsychological testing because a significant proportion of them are organic (p. 156)." While in all cases in this research attempts were made to avoid confounding the psychotic group with brain-damaged individuals, results of this study should be viewed with this limitation in mind.

Limitations of scoring system

Examinees normally complete the BGT using one and sometimes two sheets of paper to copy the nine designs. Occasionally, an examinee will use nine sheets of paper (one for each of the nine designs). This occurred on three out of the eighty protocols in this study. Usually the result of this extended use of paper space is that the examinee's figures are drawn much larger than the original ones (which are printed on 4" x 6" cards) but are internally consistent in size. Therefore, scores on linkages 1-9 are extremely high and scores on linkages 1a-9a are within the expected range. The three protocols in this study conformed to this premise (the mean scores for linkages 1-9 were 331.38, 215.61, 243.68; the mean scores for linkages 1a-9a were

115.16, 161.00, 118.38). The extreme scores created by using nine sheets of paper poses a problem when compared to scores obtained using only one or two sheets of paper. The exaggerated scores completely eliminates the discriminating power of the scoring system, forcing the scorer to rely primarily on the scores from linkages 1a-9a. This should be regarded as a limitation of the scoring system when evaluating nine-page protocols. Perhaps these exceptional cases could best be interpreted in a more traditional manner, at least until more normative data can be obtained for purposes of comparison.

The length of time required to use the scoring system accurately diminishes with one's familiarity of the system. Using all 9 linkages, the scorers in this study reported approximately 25-30 minutes per protocol scoring time. The lengthiness and tediousness of the scoring procedure could be greatly reduced by eliminating several of the linkages which appear to be less discriminating than others. Based on the research to date, those linkages which could be dropped are linkages 2, 2a, 9, and 9a. This deletion should also improve the discriminative validity of the scoring technique.

The length of time to calculate the scores could also be substantially reduced by employing the use of a computer rather than relying on a hand held calculator. It is estimated that after the above mentioned suggestions are implemented the total time to score a BGT protocol could be

reduced to 10 minutes.

Incidental findings

In all instances when testing the non-clinical group, the examinees were immediately aware of the distortions made between their drawing and the original stimulus card. When asked by the examiner to comment on these differences, they were able to do so accurately and most often apologetically. The examinees' verbal report of their inaccuracy is a clear indication that the stimulus drawing is initially perceived accurately, but becomes distorted during the examinee's attempt to reproduce it. Unfortunately, this information was not available for the clinical group.

Recommendations for future research

The BGT is usually completed in ten to fifteen minutes. Taking less than five minutes and more than thirty minutes to finish the BGT is unusual. The exact length of time for each examinee to complete the BGT was not recorded in this study, except for the exceptional cases.

An anecdotal observation of one of the non-clinical examinees who took one and one-half hours to complete the BGT proved interesting. This S's totalled mean deviation scores were the smallest in the entire sample (total score=47.10), approximately 45% less than the next closest score (84.75). This finding suggests that there might be a relationship between the length of time to complete the BGT

and the overall measure of consistency in the examinee's reproductions; however, a more accurate accounting of the time required for each examinee to complete the BGT must be made before any reliable conclusions can be drawn.

The completion time may not be the only statistic worth recording. As suggested by Das(1984), the number of times examinees look at a figure while copying it is related to their overall accuracy in reproduction. Poorer copiers seem to be looking at each part of the figure and trying to copy that part (successive processors). In contrast, the better performers take one good look at the figure (simultaneous processors) and start copying it with infrequent reference to the original drawing.

It seems possible that when viewing the figures simultaneous processors are forming a gestalt image more quickly and completely in their memory and the successive processors are either doing so additively, or are failing to do so altogether.

Das(1984) proposed a research method in which the frequency and duration of looks at a stimulus figure can be systematically recorded. "The figure is put on a screen and made available for viewing only when subjects press a viewing button with their fingers. As soon as the finger is removed for copying the drawing, the screen becomes blank (p. 235)." This research method could provide interesting and accurate time recordings for future research with the BGT.

TABLE 1

Subjects' Demographics:Mean Scores

Group	N[1]		Age[2]	Education[2]
Non-Clinical				
Older	20		69.05	12.65
Younger	20		23.80	13.30
		Total M	46.425	12.975
Clinical				
Psychotic	20		30.45	11.85
Brain-Damaged	20		30.10	11.60
		Total M	30.275	11.697

[1]each group consisted of 10 male and 10 female subjects
[2]values expressed in years

T-test P values for Group Demographics[3]

Comparisons	df	Age	df	Education[4]
		P		P
Non-Clinical vs. Clinical	78	0.000*	71[4]	0.014*
Older vs. Younger	38	0.000*	38	0.320
Older vs. Psychotic	38	0.000*	31[4]	0.348
Older vs. Brain-Damaged	38	0.000*	38	0.171
Younger vs. Psychotic	38	0.034*	31[4]	0.054
Younger vs. Brain-Damaged	38	0.036*	38	0.008*
Psychotic vs. Brain-Damaged	38	0.922	31[4]	0.763

[3]All t-tests are two-tailed.
[4]It was not possible to determine the educational level for seven of the twenty psychotic subjects. They were assigned the mean educational level for that group (M=11.85 years) for purposes of statistical analyses.
*significant difference $p<.05$.

TABLE 2

Pearson Correlation Coefficients
for Interscorer Reliability

Linkage[1]	A	B	C	D	P
1	.999	.999	.999	.999	.000
2	.994	.995	.992	.994	.000
3	.999	.997	.998	.998	.000
4	.999	.999	.999	.999	.000
5	.997	.998	.998	.998	.000
6	.998	.990	.989	.992	.000
7	.999	.999	.998	.999	.000
8	.966	.970	.963	.966	.000
9	.991	.987	.978	.985	.000
1a	.987	.983	.976	.982	.000
2a	.966	.969	.944	.960	.000
3a	.999	.995	.996	.997	.000
4a	.990	.992	.980	.987	.000
5a	.998	.996	.998	.997	.000
6a	.988	.944	.960	.964	.000
7a	.951	.943	.917	.937	.000
8a	.942	.975	.924	.947	.000
9a	.984	.965	.965	.971	.000
			Overall X =	.982	

A Correlation of first scores to second scores
B Correlation of first scores to third scores
C Correlation of second scores to third scores
D Mean correlation values for A, B and C.
[1]Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

TABLE 3

Mean Deviation Scores for Non-Clinical and Clinical Groups[2]

Linkage[1]	N-C	C	F	P
1	3.993	5.707	2.880	0.094**
2	7.608	8.812	0.988	0.323
3	8.625	13.379	9.353	0.003*
4	5.285	8.046	4.776	0.032*
5	27.188	33.643	2.133	0.148
6	6.938	10.400	5.125	0.026*
7	1.777	3.074	4.654	0.034*
8	13.719	15.917	2.882	0.094**
9	10.512	12.103	1.413	0.238
1a	3.878	4.947	2.008	0.161
2a	10.300	10.031	0.035	0.852
3a	11.350	18.181	7.365	0.008*
4a	6.613	7.327	0.314	0.577
5a	15.908	24.501	4.620	0.035*
6a	8.025	9.375	0.843	0.362
7a	1.734	2.372	3.245	0.076**
8a	14.387	19.158	3.508	0.065**
9a	11.612	13.855	1.267	0.264

N-C refers to Non-Clinical
C refers to Clinical
*significant difference($p<.05$)
**significant difference($p<.10$)
[1]Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.
[2]Complete results of a two-way analysis of variance is presented in Appendix B.

TABLE 4

Analysis of Covariance for Non-Clinical and Clinical Groups Adjusted for Age and Educational Differences

Source	df	MS	F	P
A(Group)	1	3334.352	14.13	0.0003
Covariate=Age	1	810.355	3.43	0.0679
Covariate=Educ.	1	12.682	0.05	0.8173
All Covariates	2	405.260	1.72	0.1867
Error	74	236.011		

Mean Deviation Scores for Non-Clinical and Clinical Groups Adjusted for Age and Educational Differences

Linkage'	Non-Clinical	Clinical
1	3.630	6.202
2	7.246	9.315
3	8.262	13.930
4	4.923	8.364
5	26.825	34.141
6	6.575	10.509
7	1.415	3.490
8	13.356	16.427
9	10.150	12.671
1a	3.516	5.281
2a	9.938	10.414
3a	10.988	18.954
4a	6.250	7.822
5a	15.546	23.917
6a	7.663	9.473
7a	1.372	2.753
8a	14.025	19.539
9a	11.250	14.237

'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

TABLE 5

Mean Deviation Scores for Psychotic and Brain-Damaged Groups

Linkage'	P	B-D	F	P
1	5.751	5.663	0.004	0.953
2	7.800	9.824	1.175	0.286
3	12.741	14.017	0.274	0.604
4	8.038	8.053	0.000	0.994
5	35.393	31.893	0.272	0.605
6	9.525	11.275	0.534	0.470
7	2.349	3.836	3.071	0.088
8	15.112	16.763	0.694	0.411
9	11.100	13.158	1.262	0.269
1a	4.674	5.220	0.241	0.626
2a	8.500	11.563	1.931	0.173
3a	17.837	18.525	0.024	0.879
4a	6.831	7.849	0.456	0.504
5a	22.151	26.850	0.500	0.484
6a	8.950	9.800	0.143	0.707
7a	1.783	2.961	4.630	0.039*
8a	17.711	20.605	0.685	0.414
9a	13.553	14.158	0.048	0.828

P refers to Psychotic
B-D refers to Brain-Damaged
*significant differences ($p<.05$)
'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

TABLE 6

Duncan's Comparison of Mean Deviation Scores for Four Groups[2]

Linkage[1]	O	Y	P	B-D
1	3.272 a	4.714 a	5.751 a	5.663 a
2	7.858 a	7.358 a	7.800 a	9.824 a
3	7.958 c	9.292 bc	12.742 ab	14.017 a
4	6.054 a	4.516 a	8.038 a	8.054 a
5	24.775 a	29.600 a	35.393 a	31.893 a
6	6.488 b	7.388 ab	9.525 ab	11.275 a
7	1.662 b	1.892 b	2.350 ab	3.836 a
8	14.988 ab	12.450 b	15.112 ab	16.763 a
9	11.738 a	9.288 a	11.100 a	13.158 a
1a	3.454 a	4.302 a	4.674 a	5.220 a
2a	11.175 a	9.425 a	8.500 a	11.562 a
3a	12.438 ab	10.262 b	17.838 a	18.525 a
4a	8.362 a	4.863 a	6.832 a	7.849 a
5a	19.518 ab	12.300 b	22.151 ab	26.850 a
6a	9.425 a	6.625 a	8.950 a	9.800 a
7a	1.718 a	1.750 a	1.783 a	2.960 b
8a	19.200 a	9.575 b	17.710 a	20.605 a
9a	10.450 a	12.775 a	13.553 a	14.158 a

O, Y, P and B-D refer to Older, Younger, Psychotic and Brain-Damaged respectively. Significant group differences ($p<0.05$) are indicated as follows: a=group 1, b=group 2, and c=group 3.

[1]Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

[2]Complete results of a one-way covariate analysis for the four groups is presented in Appendix D.

TABLE 7

Mean Deviation Scores for Older and Younger Non-Clinical Groups

Linkage'	Older	Younger	F	P
1	3.272	4.713	1.087	0.304
2	7.858	7.358	0.099	0.755
3	7.957	9.292	0.441	0.511
4	6.054	4.516	0.961	0.334
5	24.775	29.600	0.718	0.403
6	6.487	7.387	0.209	0.651
7	1.662	1.892	0.075	0.785
8	14.987	12.450	2.403	0.130
9	11.737	9.287	1.612	0.212
1a	3.454	4.302	0.650	0.426
2a	11.175	9.425	0.891	0.351
3a	12.438	10.262	0.810	0.374
4a	8.362	4.863	3.596	0.066
5a	19.517	12.299	2.605	0.115
6a	9.425	6.625	2.273	0.140
7a	1.718	1.750	0.006	0.938
8a	19.200	9.575	11.845	0.001*
9a	10.450	12.775	0.699	0.409

*significant difference ($p<.05$)
'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

TABLE 8

Mean Deviation Scores by Sex
in Non-Clinical Group

Linkage'	Male	Female	F	P
1	3.270	4.715	1.093	0.303
2	6.067	9.149	3.759	0.060
3	7.366	9.883	1.567	0.219
4	4.354	6.216	1.410	0.243
5	23.334	31.041	1.831	0.184
6	5.800	8.075	1.333	0.256
7	1.567	1.987	0.251	0.619
8	11.537	15.900	7.103	0.011*
9	8.637	12.387	3.777	0.060
1a	4.230	3.526	0.448	0.508
2a	9.500	11.100	0.745	0.394
3a	11.000	11.700	0.084	0.774
4a	5.737	7.488	0.900	0.349
5a	17.967	13.850	0.848	0.363
6a	8.800	7.250	0.697	0.409
7a	2.012	1.456	1.919	0.175
8a	14.125	14.650	0.035	0.852
9a	10.850	12.375	0.301	0.587

*significant difference ($p<.05$)
'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

TABLE 9

Mean Deviation Scores by Sex
for Clinical Group

Linkage'	Male	Female	F	P
1	6.384	5.029	0.846	0.364
2	9.208	8.416	0.180	0.674
3	13.951	12.807	0.221	0.641
4	8.296	7.795	0.064	0.801
5	33.951	33.335	0.009	0.927
6	11.325	9.475	0.597	0.445
7	3.538	2.585	1.126	0.296
8	14.037	17.895	3.412	0.073**
9	12.525	11.658	0.180	0.674
1a	4.768	5.127	0.104	0.749
2a	9.950	10.112	0.005	0.941
3a	18.050	18.313	0.003	0.953
4a	6.945	7.729	0.292	0.592
5a	21.933	27.068	0.597	0.445
6a	10.550	8.200	1.093	0.303
7a	2.562	2.160	0.519	0.476
8a	18.125	20.306	0.299	0.588
9a	12.675	15.167	0.631	0.432

**significant difference ($p<.10$)
'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

TABLE 10

Mean Deviation Scores by Sex
for Entire Sample

Linkage'	Male	Female	F	P
1	4.827	4.872	0.002	0.964
2	7.638	8.782	0.871	0.354
3	10.659	11.345	0.189	0.665
4	6.325	7.006	0.291	0.591
5	28.642	32.188	0.650	0.423
6	8.563	8.775	0.019	0.891
7	2.553	2.278	0.161	0.690
8	12.787	16.872	9.618	0.003*
9	10.581	12.032	1.237	0.270
1a	4.499	4.326	0.051	0.822
2a	9.725	10.606	0.375	0.542
3a	14.525	15.006	0.036	0.850
4a	6.341	7.606	1.130	0.291
5a	19.950	20.459	0.016	0.899
6a	9.675	7.725	1.789	0.185
7a	2.287	1.789	1.974	0.164
8a	16.125	17.329	0.314	0.577
9a	11.762	13.697	0.923	0.340

*significant difference ($p<.05$)
'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

TABLE 11
Duncan's Comparison of Mean Deviation Scores by Sex for Entire Sample

L[1]	O-M	O-F	Y-M	Y-F	P-M	P-F	BD-M	BD-F
1	3.210a	3.334a	3.330a	6.097a	7.462a	4.040a	5.307a	6.019a
2	6.367a	9.350a	5.768a	8.948a	8.934a	6.666a	9.483a	10.166a
3	7.466a	8.449a	7.267a	11.317a	14.085a	11.398a	13.818a	14.216a
4	5.416a	6.692ab	3.292b	5.741ab	9.917a	6.159ab	6.676ab	9.431a
5	26.750a	22.800a	19.918a	39.283a	34.018a	36.768a	33.884a	29.902a
6	6.500a	6.475a	5.100a	9.675a	10.675a	8.375a	11.975a	10.575
7	1.775a	1.550a	1.360a	2.424a	3.127a	1.572a	3.949a	3.711a
8	12.500bc	17.475ab	10.575c	14.325abc	13.375abc	16.850ab	14.700abc	19.056a
9	9.625ab	13.850a	7.650b	10.925ab	12.100ab	10.100ab	12.950ab	13.389a
1a	3.670a	3.238a	4.790a	3.814a	5.026a	4.323a	4.510a	5.931a
2a	10.400a	11.950a	8.600a	10.250a	8.850a	8.150a	11.050a	12.075a
3a	12.200a	12.675a	9.800a	10.725a	20.275a	15.400a	15.825a	21.225a
4a	7.762ab	8.963ab	3.713b	6.013ab	8.251ab	5.412ab	5.639ab	10.304a
5a	23.368ab	15.667ab	12.566b	12.033b	22.434ab	21.868ab	21.433ab	32.268a
6a	11.300a	7.550a	6.300a	6.950a	11.650a	6.250a	9.450a	10.150a
7a	2.100ab	1.337b	1.925ab	1.575ab	2.200ab	1.320b	2.925a	3.000a
8a	20.050ab	18.350ab	8.200c	10.950bc	20.350ab	14.778bc	15.900abc	25.833a
9a	8.900a	12.000a	12.800a	12.750a	13.100a	14.056a	12.250a	16.278a

O-M, O-F, Y-M, Y-F, P-M, P-F, BD-M and BD-F refer to Older-Male, Older-Female, Younger-Male, Younger-Female, Psychotic-Male, Psychotic-Female, Brain-Damaged-Male and Brain-Damaged Female respectively. Significant group differences are indicated ($p.<0.05$) as follows: a=group 1, b=group 2 and c=group 3.
[1]Linkages 1-9 refer to deviation from the objective stimulus properties. 1a-9a refer to deviation from the initial property reproductions.

TABLE 12

Mean Deviation Scores for Combined Linkages
for Four Groups

Linkage[1]	O	Y	P	B-D	F	P
1-9	84.792 a	86.497 a	107.810 a	115.171 a	2.363	0.078
1a-9a	95.740 a	71.877 b	101.363 a	116.555 a	6.765	0.001*
1-9a	180.532 bc	158.374 c	209.712 ab	231.726 a	4.699	0.005*

O, Y, P and B-D refer to Older, Younger, Psychotic and Brain-Damaged respectively. Significant group differences $p<.05$) are indicated as follows: a=group 1 and b=group 2.
[1]Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions. Linkage 1-9a refer to all eighteen linkages.

TABLE 13

Mean Deviation Scores for Combined Linkages
for Two Groups

Linkage[1]	Non-Clinical	Clinical	F	P
1-9	85.645	111.396	6.905	0.010*
1a-9a	83.808	108.959	11.528	0.001*
1-9a	169.453	220.719	11.857	0.001*

* indicates a signficant difference ($p<.05$).
[1]Linkages 1-9 refer to deviation from objective stimulus properties.
1a-9a refer to deviation from initial property reproductions.
Linkage 1-9a refer to all eighteen linkages.

TABLE 14

Mean Deviation Scores for Combined Linkages
for Entire Sample by Sex

Linkage[1]	Male	Female	F	P
1-9	92.576	104.287	1.515	0.222
1a-9a	94.890	97.294	0.215	0.644
1-9a	187.466	201.757	1.099	0.298

[1]Linkages 1-9 refer to deviation from objective stimulus properties.
1a-9a refer to deviation from initial property reproductions.
Linkage 1-9a refer to all eighteen linkages.

TABLE 15

Mean Deviation Scores for Combined Linkages* for Two Groups by Sex

	Non-Clinical		Clinical			
Linkage[1]	Male	Female	Male	Female	F	P
1-9	71.934 b	99.355 a	113.217 a	109.479 a	7.069	0.010*
1a-9a	84.222 b	83.395 b	105.559 ab	112.737 a	11.447	0.001*
1-9a	156.156 b	182.750 ab	218.776 a	222.877 a	11.838	0.001*

* indicates a signficant difference ($p<.05$).
Significant group differences ($p<.05$) are indicated as follows:
a=group 1 and b=group 2.
[1]Linkages 1-9 refer to deviation from objective stimulus properties.
1a-9a refer to deviation from initial property reproductions.
Linkage 1-9a refer to all eighteen linkages.

TABLE 16
Mean Deviation Scores for Combined
Linkages for Four Groups by Sex

Linkage[1]	O-M	O-F	Y-M	Y-F	P-M	P-F	BD-M	BD-F
1-9	79.609ab	89.975ab	64.260b	108.735a	113.693a	101.928ab	112.742a	117.869a
1a-9a	99.750bc	91.730bc	68.694c	75.060bc	112.136ab	89.392bc	98.982bc	136.081a
1-9a	179.359ab	181.705ab	132.954b	183.795ab	225.829a	191.803ab	211.724ab	253.950a

O-M, O-F, Y-M, Y-F, P-M, P-F, BD-M and BD-F refer to Older-Male, Older-Female, Younger-Male, Younger-Female, Psychotic-Male, Psychotic-Female, Brain-Damaged-Male and Brain-Damaged Female respectively. Significant group differences are indicated ($p.<0.05$) as follows: a=group 1, b=group 2 and c=group 3.
[1]Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions. Linkage 1-9a refer to all eighteen linkages.

F and P values for Table 16

Linkage	Source	F	P
1-9	A(Group)	2.438	0.072
	B(Sex)	1.515	0.222
	A x B	1.452	0.235
1a-9a	A(Group)	7.586	0.001*
	B(Sex)	0.215	0.644
	A x B	3.479	0.020*
1-9a	A(Group)	4.936	0.004*
	B(Sex)	1.099	0.298
	A x B	1.785	0.158

*significant difference ($p<.05$)

TABLE 17

Within Group Comparisons of Combined Linkage Scores

Groups	Linkage[1]	Scores	T	df	P
Older	(1-9)	84.792	-2.33	19	0.031*
	(1a-9a)	95.740			
Younger	(1-9)	86.497	1.22	19	0.238
	(1a-9a)	71.877			
Psychotic	(1-9)	108.348	0.90	18'	0.379
	(1a-9a)	101.362			
Brain-Damaged	(1-9)	115.171	-0.14	18'	0.893
	(1a-9a)	116.555			

[1]Linkages 1-9 refer to deviation from objective stimulus properties.
1a-9a refer to deviation from initial property reproductions.
*significant difference ($p<.05$)

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VI. APPENDIX A

SCORING RECORD SHEETS

MEASUREMENTS AND DEVIATIONS

Linkage	Design	Mst	ofs-	mfs-
1.(ofs: 18mm)	A.a	___	___	
	b	___	___	
	c	___	___	
	d	___	___	
	A T+1	___	___	
	X	___	___	
	4.a	___	___	___
	b	___	___	___
	c	___	___	___
	4 Ttl	___	___	___
	X	___	___	___
	7.a	___	___	___
	b	___	___	___
	c	___	___	___
	d	___	___	___
	7 Ttl	___	___	___
	X	___	___	___
	8.a	___	___	___
	b	___	___	___
	c	___	___	___
	d	___	___	___
	8 Ttl	___	___	___
	X	___	___	___
2.(ofs: 25mm)	A	___	___	
	4.	___	___	___
	5.	___	___	___
3.(ofs: 44mm)	3.	___	___	
	4.	___	___	___
	8.a	___	___	___
	b	___	___	___
	8 Ttl	___	___	___
	X	___	___	___
4.(ofs: 22mm)	5.	___	___	
	7.a	___	___	___
	b	___	___	___
	c	___	___	___
	d	___	___	___
	7 Ttl	___	___	___
	X	___	___	___
	8.a	___	___	___
	b	___	___	___
	c	___	___	___
	d	___	___	___
	8 Ttl	___	___	___
	X	___	___	___
5.(ofs: 130mm)	1.	___	___	
	2.a	___	___	___
	b	___	___	___
	c	___	___	___
	2 Ttl	___	___	___
	X	___	___	___
6.(ofs: 38mm)	4.	___	___	
	6.a	___	___	___
	b	___	___	___
	6 Ttl	___	___	___
	X	___	___	___
7.(ofs: 8mm)	7.a	___	___	
	b	___	___	
	c	___	___	
	d	___	___	
	7 Ttl	___	___	
	X	___	___	
	6.a	___	___	___
	b	___	___	___
	c	___	___	___
	d	___	___	___
	8 Ttl	___	___	___
	X	___	___	___
8.(ofs: 120°)	7.a	___	___	
	b	___	___	
	7 Ttl	___	___	
	X	___	___	
	8.a	___	___	___
	b	___	___	___
	8 Ttl	___	___	___
	x	___	___	___

Linkage	Design	Mst	ofs-	mfs-
9. (ofs: 47°)	7.a	___	___	
	b	___	___	
	7 Ttl	___	___	
	X	___	___	
	8.a	___	___	___
	b	___	___	___
	8 Ttl	___	___	___
	X	___	___	___

FINAL CALCULATION OF SCORES

LINKAGE	DESIGN	OFS-	MFS-
1.	A.	____	____
	4.	____	____
	7.	____	____
	8.	____	____
	Totals	____	____
	X Scores	____	____
2.	A.	____	
	4.	____	____
	5.	____	____
	Totals	____	____
	X Scores	____	____
3.	3.	____	
	4.	____	____
	8.	____	____
	Totals	____	____
	X Scores	____	____
4.	5.	____	
	7.	____	____
	8.	____	____
	Totals	____	____
	X Scores	____	____
5.	1.	____	
	2.	____	____
	Totals	____	____
	X Scores	____	____
6.	4.	____	
	6.	____	____
	Totals	____	____
	X Scores	____	____
7.	7.	____	
	8.	____	____
	Totals	____	____
	X Scores	____	____
8.	7.	____	
	8.	____	____
	Totals	____	____
	X Scores	____	____
9.	7.	____	
	8.	____	____
	Totals	____	____
	X Scores	____	____

VII. APPENDIX B

2 x 2 ANALYSIS OF VARIANCE

Non-Clinical and Clinical Groups x Sex

Appendix B

Linkage 1

Source	df	MS	F	P
A(Group)	1	58.773	2.880	0.094
B(Sex)	1	0.041	0.002	0.964
A x B	1	39.214	1.922	0.170
Error	76	20.406		

Linkage 2

Source	df	MS	F	P
A(Group)	1	28.989	0.988	0.323
B(Sex)	1	26.196	0.893	0.348
A x B	1	75.039	2.557	0.114
Error	76	29.350		

Linkage 3

Source	df	MS	F	P
A(Group)	1	452.109	9.353	0.003
B(Sex)	1	9.414	0.195	0.660
A x B	1	67.012	1.386	0.243
Error	76	48.340		

Linkage 4

Source	df	MS	F	P
A(Group)	1	152.407	4.776	0.032
B(Sex)	1	9.261	0.290	0.592
A x B	1	27.943	0.876	0.352
Error	76	31.912		

Appendix B(cont.)

Linkage 5

Source	df	MS	F	P
A(Group)	1	833.403	2.133	0.148
B(Sex)	1	251.445	0.644	0.425
A x B	1	346.406	0.887	0.349
Error	76	390.719		

Linkage 6

Source	df	MS	F	P
A(Group)	1	239.775	5.125	0.026
B(Sex)	1	0.903	0.019	0.890
A x B	1	85.078	1.819	0.181
Error	76	46.782		

Linkage 7

Source	df	MS	F	P
A(Group)	1	32.564	4.654	0.034
B(Sex)	1	1.403	0.201	0.656
A x B	1	9.293	1.328	0.253
Error	75'	6.997		

Linkage 8

Source	df	MS	F	P
A(Group)	1	99.699	2.882	0.094
B(Sex)	1	333.430	9.639	0.003
A x B	1	1.263	0.037	0.849
Error	75'	34.592		

Appendix B(cont.)

Linkage 9

Source	df	MS	F	P
A(Group)	1	49.216	1.413	0.238
B(Sex)	1	41.018	1.177	0.281
A x B	1	105.203	3.020	0.086
Error	75'	34.837		

Linkage 1a

Source	df	MS	F	P
A(Group)	1	22.877	2.008	0.161
B(Sex)	1	0.595	0.052	0.820
A x B	1	5.650	0.496	0.483
Error	76	11.393		

Linkage 2a

Source	df	MS	F	P
A(Group)	1	1.445	0.035	0.852
B(Sex)	1	15.532	0.379	0.540
A x B	1	10.332	0.252	0.617
Error	76	41.017		

Linkage 3a

Source	df	MS	F	P
A(Group)	1	933.320	7.365	0.008
B(Sex)	1	4.634	0.037	0.849
A x B	1	0.957	0.008	0.931
Error	76	126.726		

Appendix B(cont.)

Linkage 4a

Source	df	MS	F	P
A(Group)	1	10.361	0.314	0.577
B(Sex)	1	31.713	0.963	0.330
A x B	1	4.606	0.140	0.710
Error	75'	32.947		

Linkage 5a

Source	df	MS	F	P
A(Group)	1	1476.533	4.620	0.035
B(Sex)	1	5.176	0.016	0.899
A x B	1	427.954	1.339	0.251
Error	76	319.593		

Linkage 6a

Source	df	MS	F	P
A(Group)	1	36.450	0.843	0.362
B(Sex)	1	76.050	1.758	0.189
A x B	1	3.203	0.074	0.786
Error	76	43.251		

Linkage 7a

Source	df	MS	F	P
A(Group)	1	7.650	3.245	0.076
B(Sex)	1	4.474	1.898	0.172
A x B	1	0.115	0.049	0.826
Error	74'	2.358		

Appendix B(cont.)

Linkage 8a

Source	df	MS	F	P
A(Group)	1	453.553	3.508	0.065
B(Sex)	1	35.612	0.275	0.601
A x B	1	13.331	0.103	0.749
Error	74'	129.290		

Linkage 9a

Source	df	MS	F	P
A(Group)	1	103.687	1.267	0.264
B(Sex)	1	78.489	0.959	0.331
A x B	1	4.547	0.056	0.814
Error	74'	81.826		

VIII. APPENDIX C

4 x 2 ANALYSIS OF VARIANCE

Older, Younger, Psychotic and Brain-Damaged Groups x Sex

Appendix C

Linkage 1

Source	df	MS	F	P
A(Group)	3	26.543	1.300	0.281
B(Sex)	1	0.041	0.002	0.964
A x B	3	33.134	1.623	0.192
Error	72	20.414		

Linkage 2

Source	df	MS	F	P
A(Group)	3	24.161	0.803	0.496
B(Sex)	1	26.196	0.871	0.354
A x B	3	32.303	1.074	0.366
Error	72	30.072		

Linkage 3

Source	df	MS	F	P
A(Group)	3	162.061	3.248	0.027
B(Sex)	1	9.414	0.189	0.665
A x B	3	38.107	0.764	0.518
Error	72	49.895		

Linkage 4

Source	df	MS	F	P
A(Group)	3	58.683	1.843	0.147
B(Sex)	1	9.263	0.291	0.591
A x B	3	45.810	1.439	0.239
Error	72	31.835		

Appendix C(cont.)

Linkage 5

Source	df	MS	F	P
A(Group)	3	396.250	1.024	0.387
B(Sex)	1	251.445	0.650	0.423
A x B	3	606.237	1.566	0.205
Error	72	387.042		

Linkage 6

Source	df	MS	F	P
A(Group)	3	92.834	1.931	0.132
B(Sex)	1	0.903	0.019	0.891
A x B	3	46.667	0.971	0.411
Error	72	48.081		

Linkage 7

Source	df	MS	F	P
A(Group)	3	18.707	2.683	0.053
B(Sex)	1	1.122	0.161	0.690
A x B	3	5.638	0.809	0.493
Error	71'	6.972		

Linkage 8

Source	df	MS	F	P
A(Group)	3	65.487	1.864	0.143
B(Sex)	1	337.914	9.618	0.003
A x B	3	2.199	0.063	0.979
Error	71'	35.133		

Appendix C(cont.)

Linkage 9

Source	df	MS	F	P
A(Group)	3	51.118	1.454	0.234
B(Sex)	1	43.485	1.237	0.270
A x B	3	39.372	1.120	0.347
Error	71	35.150		

Linkage 1a

Source	df	MS	F	P
A(Group)	3	11.016	0.940	0.426
B(Sex)	1	0.595	0.051	0.822
A x B	3	5.889	0.503	0.682
Error	72	11.718		

Linkage 2a

Source	df	MS	F	P
A(Group)	3	41.953	1.012	0.393
B(Sex)	1	15.532	0.375	0.542
A x B	3	5.932	0.143	0.934
Error	72	41.464		

Linkage 3a

Source	df	MS	F	P
A(Group)	3	328.451	2.539	0.063
B(Sex)	1	4.634	0.036	0.850
A x B	3	88.467	0.684	0.565
Error	72	129.370		

Appendix C(cont.)

Linkage 4a

Source	df	MS	F	P
A(Group)	3	48.629	1.571	0.204
B(Sex)	1	34.993	1.130	0.291
A x B	3	48.432	1.564	0.206
Error	71'	30.959		

Linkage 5a

Source	df	MS	F	P
A(Group)	3	739.460	2.305	0.084
B(Sex)	1	5.176	0.016	0.899
A x B	3	293.787	0.916	0.438
Error	72	320.747		

Linkage 6a

Source	df	MS	F	P
A(Group)	3	40.692	0.957	0.418
B(Sex)	1	76.050	1.789	0.185
A x B	3	48.209	1.134	0.341
Error	72	42.501		

Linkage 7a

Source	df	MS	F	P
A(Group)	3	7.243	3.195	0.029
B(Sex)	1	4.474	1.974	0.164
A x B	3	0.916	0.404	0.750
Error	70'	2.267		

Appendix C(cont.)

Linkage 8a

Source	df	MS	F	P
A(Group)	3	487.018	4.292	0.008
B(Sex)	1	35.610	0.314	0.577
A x B	3	215.438	1.899	0.138
Error	70'	113.465		

Linkage 9a

Source	df	MS	F	P
A(Group)	3	53.621	0.631	0.598
B(Sex)	1	78.489	0.923	0.340
A x B	3	17.213	0.202	0.894
Error	70'	85.006		

IX. APPENDIX D

ONE-WAY ANAYSIS OF VARIANCE

APPENDIX D

Mean Deviation Scores for Entire Sample

L'	O	Y	P	B-D	F	P
1	3.272	4.714	5.751	5.663	1.286	0.286
2	7.858	7.358	7.800	9.824	0.802	0.496
3	7.958	9.292	12.742	14.017	3.314	0.024*
4	6.054	4.516	8.038	8.054	1.829	0.149
5	24.775	29.600	35.393	31.893	1.010	0.395
6	6.488	7.388	9.525	11.275	1.958	0.127
7	1.662	1.892	2.350	3.836	2.692	0.052**
8	14.988	12.450	15.112	16.763	1.641	0.187
9	11.738	9.288	11.100	13.158	1.422	0.243
1a	3.454	4.302	4.674	5.220	0.971	0.411
2a	11.175	9.425	8.500	11.562	1.056	0.373
3a	12.438	10.262	17.838	18.525	2.604	0.058**
4a	8.362	4.863	6.832	7.849	1.501	0.221
5a	19.518	12.300	22.151	26.850	2.344	0.080**
6a	9.425	6.625	8.950	9.800	0.943	0.424
7a	1.718	1.750	1.783	2.960	3.137	0.030*
8a	19.200	9.575	17.710	20.605	4.153	0.009*
9a	10.450	12.775	13.553	14.158	0.631	0.597

L, O, Y, P, B-D refer to Linkage, Older, Younger, Psychotic and Brain-Damaged respectively.
*Significant group difference ($p<.05$)
**Significant group difference ($p<.10$)
'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

X. APPENDIX E

ONE-WAY COVARIATE ANALYSIS

APPENDIX E

Analysis of Covariance Results for Entire Sample

Source	df	MS	F	P
A(Group)	3	1308.438	5.58	0.0017
Covariate=Age	1	872.364	3.72	0.0576
Covariate=Educ.	1	9.763	0.04	0.8388
All Covariates	2	439.758	1.88	0.1605
Error	72	234.359		

Adjusted Mean Deviation Scores for Entire Sample Groups

Linkage'	O	Y	P	B-D
1	0.504	5.992	6.633	6.578
2	5.090	8.636	8.684	10.752
3	5.189	10.570	13.447	15.218
4	3.286	5.795	8.487	9.046
5	22.007	30.879	36.703	32.385
6	3.719	8.666	9.684	12.139
7	-1.106	3.170	3.118	4.668
8	12.219	13.728	16.066	17.595
9	8.969	10.566	12.158	13.989
1a	0.686	5.580	5.190	6.178
2a	8.407	10.703	9.184	12.450
3a	9.669	11.541	18.382	20.331
4a	5.594	6.141	7.770	8.680
5a	16.749	13.578	23.054	25.586
6a	6.657	7.903	9.158	10.595
7a	-1.050	3.028	2.520	3.792
8a	16.432	10.853	18.447	21.437
9a	7.682	14.053	14.290	14.989

O, Y, P and B-D refer to Older, Younger, Psychotic and Brain-Damaged respectively.
'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

XI. APPENDIX F

2 x 2 COVARIATE ANALYSIS

Non-Clinical and Clinical Groups x Sex

APPENDIX F

Anaysis of Covariance Results by Sex for Two Groups

Source	df	MS	F	P
A(Group)	1	3285.534	13.83	0.0004
B(Sex)	1	200.746	0.84	0.3611
A x B	1	147.707	0.62	0.4330
Covariate=Age	1	765.970	3.22	0.0768
Covariate=Educ.	1	8.701	0.04	0.8488
All Covariates	2	383.000	1.61	0.2066
Error	72	237.588		

Adjusted Mean Deviation Scores by Sex for Two Groups

Linkage'	NC-M	NC-F	C-M	C-F
1	2.956	4.333	6.814	5.492
2	5.753	8.766	9.638	8.926
3	7.052	9.500	14.381	13.397
4	4.040	5.834	8.726	7.930
5	23.020	30.659	34.381	33.844
6	5.486	7.692	11.485	9.394
7	1.253	1.604	3.968	2.928
8	11.223	15.517	14.467	18.574
9	8.323	12.005	12.955	12.324
1a	3.916	3.143	5.198	5.343
2a	9.186	10.717	10.380	10.422
3a	10.686	11.317	18.480	19.450
4a	5.423	7.105	7.375	8.289
5a	17.653	13.467	22.363	25.613
6a	8.486	6.867	10.980	7.769
7a	1.698	1.073	2.992	2.456
8a	13.811	14.267	18.555	20.602
9a	10.536	11.992	13.105	15.463

NC-M, NC-F, C-M and C-F refer to Non-Clinical Male, Non-Clinical Female, Clinical Male and Clinical Female.
'Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.

XII. APPENDIX G

4 x 2 COVARIATE ANALYSIS

Older, Younger, Psychotic and Brain-Damaged Groups x Sex

APPENDIX G

Analysis of Covariance Results by Sex for Four Groups

Source	df	MS	F	P
A(Group)	3	1227.212	5.31	0.0024
B(Sex)	1	160.405	0.69	0.4076
A x B	3	335.674	1.45	0.2352
Covariate=Age	1	523.768	2.27	0.1368
Covariate=Educ.	1	14.251	0.06	0.8046
All Covariates	2	268.133	1.16	0.3195
Error	68	231.052		

APPENDIX G(cont.)

Adjusted Mean Deviation Scores by Sex for Entire Sample

L[1]	O-M	O-F	Y-M	Y-F	P-M	P-F	BD-M	BD-F
1	1.003	1.129	4.448	6.976	8.045	4.767	6.216	6.647
2	4.160	7.145	6.886	9.827	9.517	7.463	10.392	10.819
3	5.259	6.244	8.385	12.196	14.668	11.795	14.727	15.430
4	3.209	4.487	4.410	6.620	10.500	5.955	7.585	10.336
5	24.543	20.595	21.036	40.162	34.601	38.743	34.793	29.377
6	4.293	4.270	6.218	10.554	11.258	7.640	12.344	11.579
7	-0.432	-0.655	2.478	3.303	3.710	2.164	4.858	4.123
8	10.293	15.270	11.693	15.204	13.958	18.112	15.609	19.468
9	7.418	11.645	8.768	11.804	12.683	11.278	13.859	13.801
1a	1.463	1.033	5.908	4.693	5.609	4.428	5.419	6.688
2a	8.193	9.745	9.718	11.129	9.433	8.612	11.959	12.662
3a	9.993	10.470	10.918	11.604	20.858	15.334	16.734	23.996
4a	5.555	6.758	4.831	6.892	8.834	6.292	6.548	10.717
5a	21.161	13.462	13.684	12.912	23.017	22.798	22.342	28.858
6a	9.093	5.345	7.418	7.829	12.233	5.445	10.359	10.523
7a	-0.107	-0.868	3.043	2.454	2.783	1.932	3.834	3.412
8a	17.843	16.145	9.318	11.829	20.933	15.390	16.809	26.246
9a	6.693	9.795	13.918	13.629	13.683	14.667	13.159	16.690

L, O-M, O-F, Y-M, Y-F, P-M, P-F, BD-M and BD-F refer to Linkage, Older-Male, Older-Female, Younger-Male, Younger-Female, Psychotic-Male, Psychotic-Female, Brain-Damaged Male and Brain-Damaged Female respectively.

[1]Linkages 1-9 refer to deviation from objective stimulus properties. 1a-9a refer to deviation from initial property reproductions.